SPAWAR Systems Center San Diego

Annual Publications Supplement: 2007

"Advances in Autonomous Obstacle Avoidance for Unmanned Surface Vehicles,"

Larson, J., Bruch, M., Halterman, R., Rogers, J., and R. Webster,
AUVSI Unmanned Systems North America, Washington, D.C., August 6-9, 2007.

The Space and Naval Warfare Systems Center, San Diego, has been involved in the continuing development of obstacle avoidance for unmanned surface vehicles (USVs) towards the aim of a high level of autonomous navigation. An autonomous USV can fulfill a variety of missions and applications that are of increasing interest to the US Navy and other Department of Defense and Department of Homeland Security organizations. The USV obstacle-avoidance package first creates an accurate world model based on various sensors, such as vision, radar, and nautical charts. The USV can then avoid obstacles with the use of a far-field deliberative obstacle avoidance component and a near-field reactive obstacle avoidance component. This paper addresses the advances made in USV obstacle avoidance during the last two years.
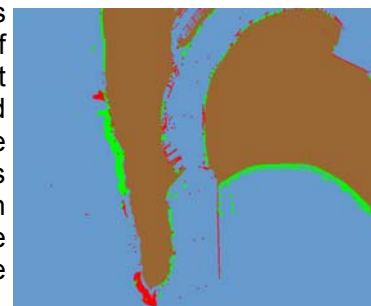
"Sensor Fusion for Intelligent Behavior on Small Unmanned Ground Vehicles,"

Kogut, G.T., Sights, B., Ahuja, G., Pacis, E.B., Birchmore, F., and H.R. Everett,   SPIE Proc. 6561: Unmanned Systems Technology IX, Defense & Security Symposium, Orlando, FL, April 9-13, 2007.

Sensors commonly mounted on small unmanned ground vehicles (UGVs) include visible light and thermal cameras, scanning lidar, and ranging sonar. Reliable data from these sensors are vital to emerging autonomous robotic behaviors. However, data from any given sensor can become noisy or erroneous under a range of real-world conditions, reducing the reliability of autonomous operations. We seek to increase this reliability through data fusion. Data fusion includes characterizing the strengths and weaknesses of each sensor modality and combining their data in a way such that the result of the data fusion provides more accurate data than any single sensor. We describe data fusion efforts applied to two autonomous behaviors: leader-follower and human presence detection. The behaviors are implemented and tested in a variety of realistic conditions.

## "Unmanned Ground Vehicle Radio Relay Deployment System for Non-Line-of-Sight Operations,"

Pezeshkian, N., Nguyen, H.G., and A. Burmeister,   Proc. 13th IASTED Int. Conference on Robotics and Applications, Wuerzburg, Germany; August 29-31, 2007.

Tactical mobile robots used in military and law enforcement operations normally require a robust long-range non-line-of-sight (NLOS) communications link to the remote control station. High-frequency digital radio communications, currently the preferred technology, are subject to line-of-sight (LOS) limitations, and thus are often impossible to maintain in urban environments. We have developed a system that will allow the mobile robot to carry multiple radio relays that are automatically deployed when and where needed in order to maintain robust communications. This process is completely transparent to the operator and is entirely handled by the ad-hoc network formed by the radio relays. Experimental data compares the effective range achieved with and without the use of our relay deployment system.

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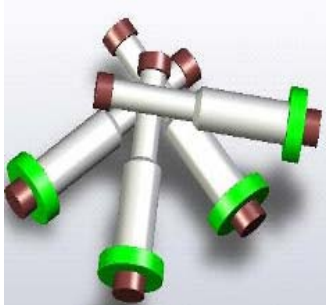
"Geometrically Optimized Labr3:Ce Scintillation Sensor Array for Enhanced Stand-Off Direction Finding of Gamma Radiation Sources,"

Winso, J.H., Ackermann, Eric S., Fennell, Michael, Perez, Roger, Rolando, John, Pagey, Manish, Polichar, Raulf, Martinez, Juan, Hovgaard, Jens, Kogut, Greg, Everett, H.R., Fellars, Donnie, Baumbaugh, Joel, and Mastny, Gary, IEEE Nuclear Science Symposium, Honolulu, HI, October 27-November 3, 2007.

A Radiation Source Identification and Targeting (RadSITE™) innovation has been conceptually demonstrated that remotely detects and identifies one or more localized gamma sources and also provides azimuth directions of each source. The innovation exploits the superior energy resolution of Cerium-doped Lanthanum Bromide (LaBr3:Ce) scintillators to select only photons emanating directly from the localized source(s). The response of

each sensor element is anisotropic, providing a response dependent on the azimuth of the source relative to the sensor. The integrated response of the entire array is isotropic, providing a source strength-distance indicator to act as a reference for an original software algorithm that processes each isotope response to determine azimuth. Laboratory tests have confirmed that an array of four sensors would be sufficient to provide ±5° azimuth determination over a 360° field of view. The approach accommodates a large volume of scintillation material with minimal shielding (<20% compared to about 50% for coded-aperture approaches to provide a high sensitivity and a wide (360°) field of view). This patent-pending innovation has been integrated with an iRobot ATRV robotic platform to demonstrate autonomous approach to isotopic sources in a field environment.
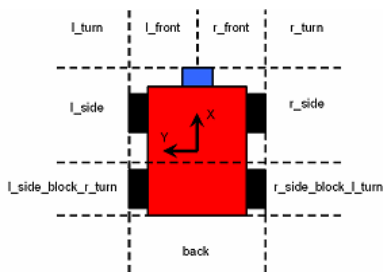
"Modular Robotic Intelligence System Based on Fuzzy Reasoning and State Machine Sequencing,"

Sights, B., Ahuja, G., Kogut, G., Pacis, E.B., Everett, H.R., Fellars, D., and S. Hardjadinata,   SPIE Proc. 6561: Unmanned Systems Technology IX, Defense & Security Symposium, Orlando, FL, April 9-13, 2007.

The fusion of multiple behavior commands and sensor data into intelligent and cohesive robotic movement has been a focus of robotic research for many years. Sequencing low-level behaviors to create high-level intelligence has also been extensively researched. Cohesive robotic movement is also dependent on

other factors, such as environment, user intent, and perception. In this paper, a method for managing the complexity derived from the increase in sensors and perceptions is described. Our system uses fuzzy logic and a state machine to fuse multiple behaviors into an optimal response based on the robot's current task. The resulting fused behavior is filtered through fuzzy-logic-based obstacle avoidance to create safe movement. The system also provides easy integration with any communications protocol, plug-and-play devices, perceptions, and behaviors. Most behaviors and the obstacle-avoidance parameters are easily changed through configuration files. Combined with previous work in the area of navigation and localization, a very robust autonomy suite is created.
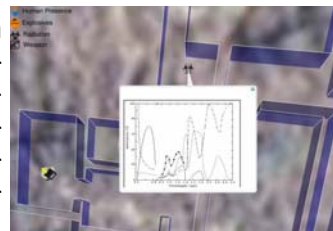

"Layered Augmented Virtuality,"

Ahuja, G., Kogut, G., Pacis, E.B., Sights, B., Fellars, D., and H.R. Everett,   Proc. 13th IASTED Int. Conference on Robotics and Applications, Wuerzburg, Germany; August 29-31, 2007.

Advancements in robotic platform functionalities and autonomy make it necessary to enhance the current capabilities of the operator control unit (OCU) for the operator to better understand the information provided from the robot. Augmented virtuality is one technique that can be used to improve the user interface, augmenting a virtual-world

representation with information from onboard sensors and human input. Standard techniques for displaying information, such as embedding information icons from sensor payloads and external systems (e.g. other robots), could result in serious information overload, making it difficult to sort out the relevant aspects of the tactical picture. This paper illustrates a unique layered approach to augmented virtuality that specifically addresses this need for optimal situational awareness.